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Effect of integrated nutrient management on growth and yield in black gram (*Vigna mungo* L. Hepper) under doon valley condition

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Abstract
The field experiment entitled ''Effect of Integrated Nutrient Management on Growth and Yield in Black gram (*Vigna mungo* L. Hepper) under Doon valley condition'' was conducted during Rabi season of 2018 at the Department of Agronomy, Doon (PG) College of Agriculture Science and Technology, Dehradun (Selaqui). The experiment was laid out in a Randomized Block Design with 08 treatments with three replications and the layout plan is given as follows: T1- Control (No fertilizer); T2- RDF (20:60:20 kg NPK/ha) + Rhizobium; T3-FYM @ 4 t/ha; T4- 100% RDF (inorganic) +FYM @ 2t/ha + Rhizobium; T5- 50% RDF (inorganic) +FYM @ 2t/ha + Rhizobium; T6- Vermicompost @ 2 t/ha + Rhizobium; T7- 100% RDF (inorganic) + Vermicompost @ 1.0 t/ha + Rhizobium; T8- 50% RDF (inorganic) + Vermicompost @ 1.0 t/ha +Rhizobium. Results showed that different effect of integrated nutrient management treatments had significant effect on all the growth parameters (Plant height, plant population, No. Of branches/plant, percent of flowering, number of root nodules) and yield attributes (number of pods/plant, pod length and seeds/pod, seed straw, biological yields of black gram. The maximum values of these parameters was recorded in the treatment with T4- 100% RDF (inorganic) + FYM @2 t/ha + Rhizobium followed by T7-100% RDF (inorganic) + Vermicompost @1.0 t/ha + Rhizobium.

Keywords: Integrated nutrient, black gram, *Vigna mungo* L. hepper, doon valley

Introduction

Black gram (*Vigna mungo* L. Hepper) is one of the most important leguminous crops among the various grain legumes. Legumes are considered to be the most important source of protein in tropical and sub tropical countries, where diets in general are deficient in protein. Pulses contain a high percentage of quality protein nearly three times as much as cereals. They also provide substantial qualities of minerals and vitamins to the diet. Black gram is a rich protein food. It contains about 26% protein, 1.2% fat and 56.6% carbohydrates on dry weight basis and it is rich source of calcium and iron. Apart from this, black gram forms excellent forage and it gives a profuse vegetative growth and covers the ground so well that it checks the soil erosion. It also forms a good silage and green manure crop. Being drought tolerant and warm weather crop, black gram is well adopted to the drier regions of the tropics, where other food legumes do not perform well. It has ability to fix about 22.10 kg of atmospheric nitrogen per hectare through its root nodules. In addition, it is shade tolerant and therefore compatible as an intercrop with maize, millet, sorghum, sugarcane and cotton. (FAOSTAT, 2012).

The major black gram growing countries include Africa, Myanmar and Thailand. In India larger portion of black gram is cultivated in the states of Madhya Pradesh, Maharashtra, Uttar Pradesh, Rajasthan, Karnataka and Bihar with a production of 18.80 lakh tonnes and productivity of 451.61 kg ha-1. In Karnataka, it occupies an area of 90.60 thousand hectare of with production of 5.67 lakh tonnes and productivity of 1447.2 kg ha-1 (Agropedia, 2012). In India seed requirement is 0.147 lakh tonnes, seed availability would be 0.249 lakh tonnes and in Karnataka seed requirement is 0.074 lakh tonnes and availability is 0.057 lakh tonnes respectively. (http://seed net.gov.in 2011)

The factors attributed for low yields of pulses in India as compared to the world productivity are non-availability of quality seeds of improved and short duration varieties, growing of pulses under marginal and less fertile soil with low inputs and without pest and disease management, growing of pulses under moisture stress, unscientific post-harvest practices and storage under unfavorable conditions. Hence, there is scope for improving the production potential of this crop by use of inorganic and bio-fertilizers. India has made spectacular breakthrough in the production and consumption of fertilizers during the last four decades.

But consumption of renewable form of energy i.e. chemical fertilizers will be quite limiting factor of agricultural production in future. Because of escalating energy cost, chemical fertilizers are not available at affordable price to the farmers. Moreover the imbalance and continuous use of chemical fertilizers has adverse effect on physical, chemical and biological properties of soil and there by affecting the sustainability of crop production, besides causing hazardous to human health and environmental pollution. Chemical fertilizers are playing crucial role to meet the nutrient requirements of the crop. Persistent nutrient depletion is posing a greater threat to the sustainable agriculture. Therefore, there is an urgent need to reduce the usage of chemical fertilizers and in turn increase in the usage of organics which is needed to check the yield and quality levels. Use of organics alone does not result in spectacular increase in crop yields, due to their low nutrient status. Therefore, the aforesaid consequences have paved way to grow black gram using inorganic along with biofertilizers. The use of bio-fertilizers is proving more eco-friendly in nature. They can play a significant role in fixing atmospheric nitrogen and plant growth promoting substances and making phosphorus available to plants by bringing about favorable change in soil micro environment leading to solubilization of insoluble organic phosphate sources. Fixed phosphate can be dissolved by microbial organic acids. The application of bio-fertilizers is 4 very essential because insoluble phosphate which is not directly available to plant usually comprises around 95-99% of the total soil phosphorus.

The basic concept of integrated nutrient management is the supply of required plant nutrient for sustaining the desired crop productivity with minimum deleterious effect on soil health environment. Integrated nutrient management intended for four major goals to be achieved:

1. To maintain soil productivity,
2. To ensure sustainable productivity,
3. To prevent degradation of the environment and
4. To reduce the expenditure on the cost of chemical fertilizers.

The optimum plant density can provide congenial condition to have maximum light interruption right from the early growth stage to pod filling stage. By changing the plant spacing, it is possible to achieve optimum vegetative and reproductive growth to boost up seed productivity per unit area.

Keeping in view of the above facts, a field experiment entitled, ‘‘Effect of Integrated Nutrient Management on Growth and Yield in Black gram (*Vigna mungo* L. Hepper) under Doon valley condition’’ will be conducted to fulfill the following objectives:

1. To study the effect of integrated nutrient management on growth of Black gram.
2. To study the effect of integrated nutrient management on yield of Black gram.
3. To study the effect of integrated nutrient management on Economics of different treatments in black gram

Material and Methods

The experiment was conducted to identify potential effect of Integrated Nutrient Management on growth and yield in Black Gram under Doon valley condition. The investigation was performed at research plot, Department of Agronomy, Doon (PG) College of Agriculture Science and Technology, Dehradun (Selaqui). The experiment was performed during Rabi season in 2018. The design used to analyze and perform experiment was Randomized Block Design with Eight treatments and Three replication. Treatments used are following: T1- Control (No fertilizer); T2- RDF (20:60:20 kg NPK/ha) + Rhizobium; T3-FYM @ 4 t/ha; T4- 100% RDF (inorganic) + FYM @ 2 t/ha + Rhizobium; T5- 50% RDF (inorganic) + FYM @ 2 t/ha + Rhizobium; T6- Vermicompost @ 2 t/ha + Rhizobium; T7- 100% RDF (inorganic) + Vermicompost @ 1.0 t/ha + Rhizobium; T8- 50% RDF (inorganic) + Vermicompost @ 1.0 t/ha + Rhizobium. Plot size was 4 m x 3 m (12 m2) with spacing of 30 cm between row and 10 cm between plants.

Variety used during experimentation was T9

(Thanjavur) at the seed rate of 20 kg ha-1. Recommended Dose of Fertilizer as per treatment was applied 20:60:20 kg NPK ha-1. Total 04 no. of Irrigation was applied to fulfill the requirement of water to the crop. The observations were recorded for Developmental studies like Days to flower initiation, Days to 50 percent flowering, Days to maturity and Growth parameters like Plant height (cm), Number of branches per plant, Plant population per plot, Number of root nodules/plant, while yield attributing characters like Number of pods per plant, Number of seeds per pod, Seed weight and Final yield was recorded on observation parameters like Biological yield (kg ha-1), Seed yield (kg ha-1), Stover yield (kg ha-1) and Harvest index (%). Economics of the treatments were analyzed on Cost of cultivation (Rs ha-1), Gross monetary return (Rs ha-1), Net monetary return (Rs ha-1) and B:C ratio.

Result and Discussion

Growth parameters

Plant Height: Data indicated that the maximum 28.8, 31.5 cm at 30, 60 and At harvest respectively) was recorded with T1 (control) followed by T3 (100% FYM).

Plant population/m2: The scrutiny of data indicated that plant populations observed similar trend both at 15 DAS and at harvest and found statistically non-significant among all the integrated nutrient management treatments. Thus, the plant stand was almost uniform in all the treated plots.

No. of branches/plant: The number of primary branches (plant-1) recorded at 30, 60 DAS and at harvest was significantly affected by different integrated nutrient management treatments. The number of primary branches (plant-1) at 30 DAS (3.78), 60 DAS (5.68) and at harvest (9.2) was registered significantly higher under T4 (100% NPK + 100% FYM+ Rhizobium), followed by T7 (100% NPK+ Vermicompost 2 ton per ha) were recorded. The significantly lowest number of primary branches (plant-1) of 2.83, 4.10 and 6.0 were recorded at 30, 60 DAS and at harvest, respectively was recorded under T1 (control).

Percent of flowering and Days to maturity:

The effect of flower initiation in integrated nutrient management was recorded differently in the above treatments were (27.6) days in T4 (100% NPK per ha + FYM 2 ton per ha + Rhizobium) followed by (28.4) days in T5 (50% NPK per ha + FYM 2 ton per ha + Rhizobium) were recorded minimum duration and maximum recorded in T1 Control (32.4) days followed by (30.7) days in T3 (FYM 4 t ha-1).

There is an effect of 50% flowering by applying different nutrients in the above treatments plant height (15.8, 38.4, 48.8 cm) at 30 DAS, 60 DAS and At harvest after sowing (DAS), was were (33.9) days in T4 (100% NPK + FYM 2 ton recorded in T4 (100% NPK + 100% FYM + Rhizobium) followed by T7 (100% NPK + 100%vermicompost + Rhizobium) at all crop growth stages and the minimum plant height (12.1, ha-1 + Rhizobium) followed by (33.5) days T5 (50% NPK ha-1 + FYM 2 ton ha-1 + Rhizobium) was recorded as minimum duration and the maximum duration were recorded in (37.1) days in T1 (Control) followed by (34.7) days in T3 (FYM 4 ton ha-1.

The number of days taken for maturity is effected by integrated nutrient management were recorded minimum duration of (62.4) days in T4 (100% NPK ha-1 + FYM 2 t ha-1 + Rhizobium) and (62.4) days also in T8 (50% NPK ha-1 + Vermicompost 1 ton ha-1 + Rhizobium) followed by (63.4) days in T7 (100% NPK ha-1 + Vermicompost 1 t ha-1 + Rhizobium) and recorded followed by T7 (100% Vermicompost 2 ton ha-1 + Rhizobium) was proved significantly high with (18.3) mg, (15.5) mg plant-1 at 45, 60 DAS followed by (17.6) mg, (15.5) mg plant-1 at 45, 60 DAS.

Weight of 100 seeds (In gms)

The weight of 100 seeds of all the treatments was deviated significantly. The data indicate that (4.3) gms in T4 (100-1maximum duration about (67.9) days in T1% NPK + FYM 2 ton ha+ Rhizobium) followed (Control) followed by (66.6) days in T3 (FYM 4 t by (4.1) gms in T7 (100% NPK + Vermicompost 1-1ha-1). ton ha+ Rhizobium) recorded maximum weight

Yield Parameters

No. of pods/plant, No. of seeds/pod and pod length:

A perusal of data showed that Number of pods per plant, Number of seeds per pod and Pod length was recorded at harvest was significantly influenced by different fertility levels and the data further revealed that the maximum number of pods per plant was attained (31.6) pods plant-1, maximum number seeds per plant was (6.6) seeds per pod and pod length was attained (5.2) cm in T4(100% NPK ha-1 + FYM 2 t ha-1 + Rhizobium) followed by (30.6) pods per plant, (6.3) seeds per compared with all other treatments significantly and recorded minimum of (3.2) gms in T1 (Control) followed by (3.4) gms in T3 (FYM 4 ton ha-1).

Grain yield (g) plant-1

The data on grain yield (g) plant was recorded maximum of (8.06) gms in T4 (100% NPK ha-1 + FYM 2 ton ha-1 + Rhizobium) followed by (7.90) gms in T7 (100% NPK ha-1 + VC 1 ton ha-1 + Rhizobium). However, lowest increase was recorded with (4.18) gms in T3 (FYM 4 ton ha-1) over all the treatments but it was higher in comparison to control (T1). pod and pod length was attained (5.1) cm in T7.

Grain yield (kg) plot-1

All the treatments showed (100% NPK ha-1 + Vermicompost 1 t ha-1 + Rhizobium). Data also revealed that minimum number of pods per plant were recorded (19.6) pods plant-1, (4.6) seeds pod-1 and pod length (4.1) cm was a significant increase in grain yield per plot over the control. The data on grain yield (g) per plant was recorded maximum of (1.22) kg/plot in T4 (100% NPK ha-1 + FYM 2 ton ha-1+ Rhizobium) followed by (1.20) kg in T7 (100% NPK ha-1 + VC-1 attained in T1 (Control) followed by (24.6) pods 1 ton ha+ Rhizobium). However, lowest increase plant-1, (5.0) seeds pod-1 and (4.2) cm pod length was attained in T3 (FYM 4 t ha-1). Root nodules/plant (in mg): application of different fertility levels and bio-fertilizers significantly increased number of effective root nodules per plant. Data further revealed that application of (100% FYM 4 ton ha-1) in T3 was recorded with (0.59) kg in T3 (FYM 4 ton ha-1) over all the treatments but it was higher in comparison to control (T1).

Effect of different INM treatments on final yields (kg/ha)

Grain yield/ha (in kg): All the treatments showed significant increase in grain yield per ha (in kg) over the control. The data on grain yield (in kg) per ha was recorded maximum of (2442) kg/plot in T4 (100% NPK per ha + FYM 2 ton per ha+ Rhizobium) followed by (3,792) kg in T7 (100% NPK per ha + VC 1 ton ha-1 + Rhizobium). higher GMR (Rs 125156 ha-1) as compared with other treatments and GMR (Rs 46275 ha-1) was recorded lowest under (T1) Control.-1

However, lowest increase was recorded with Net.

Monetary Returns (Rs ha)

The net (1195) kg in T3 (FYM 4 ton ha-1) over all the treatments but it was higher in comparison to control (T1).

Stover yield (kg/ha): It is evident that all the integrated nutrient management treatments were failed to show significant effect on Stover yield (kg ha-1). However, numerically, the value of Stover yield (kg ha-1) was registered higher in T4 (100% NPK + 50% FYM + Rhizobium) of (3056 kg ha-1) and lowest value of Stover yield (2625 kg ha-1) was recorded under control (T1).

Biological yield (kg/ha)

The perusal of data shows that the biological yield (kg/ha) was significantly affected by different integrated nutrient management treatments. The biological yield of 5498 kg/ha was recorded significantly higher with application of (100% NPK + FYM 2 t/ha+ Rhizobium) in T4 and recorded lowest of 3498 kg/ha in T1 (Control).

Harvest index (%)

The perusal of data shows that the Harvest index (%) was significantly affected by different integrated nutrient management treatments. The Harvest index (%) of 44.5% and 44.4% was recorded significantly higher with application of (100% NPK + FYM 2 t/ha +Rhizobium) in T4, (100% NPK + VC 1 t/ha + Rhizobium) in T7 and then recorded lowest of 24.9% in T1 (Control).

Economics

Gross Monetary Returns (Rs ha-1): The gross monetary returns (GMR) was significantly affected by different integrated nutrient management treatments. The application of 100% RDF + FYM 2 t/ha + Rhizobium (T4) recorded the significantly monetary returns (NMR) was significantly affected by different integrated nutrient management treatments. The application of 100% RDF + FYM 2 t ha-1 + Rhizobium (T4) recorded the significantly higher NMR (Rs 1,01,858 ha-1) as compared with other treatments and NMR (Rs 26,455 ha) was recorded lowest under (T1) Control.

Benefit-Cost Ratio

The benefit cost ratio (B:C) was also significantly affected by different integrated nutrient management treatments. The application of 100% RDF + FYM 2 t ha-1 + Rhizobium (T4) recorded the significantly higher benefit cost ratio (4.3) as compared with other treatments and benefit cost ratio (1.3) was recorded lowest under (T1) Control.

Table 1: Effect of different Integrated Nutrient Management treatments on Growth Parameters:

Treatments	Plant height (cm)			Plant population/m2		No. of branches/plant			Days to		
	30 DAS	60 DAS	At harvest	15 DAS	At harvest	30 DAS	60 DAS	At harvest	flower initiation	50% Flower -ing	Matur -ity
T1 (Control)	12.1	28.8	31.5	31.6	27.3	2.83	4.10	6.0	32.4	37.1	67.9
T2 (100% NPK/ha)	13.3	33.4	45.3	32.0	28.6	3.28	5.38	8.2	29.6	34.7	66.1
T3 (100%FYM+Rhizobium)	13.1	34.3	42.5	32.0	28.6	3.13	5.21	8.7	30.7	35.7	66.6
T4 (100%NPK+50%FYM+Rhizobium)	15.8	38.4	48.8	33.3	30.3	3.78	5.68	9.2	27.6	33.9	62.4
T5 (50% NPK+50%FYM+Rhizobium)	15.0	35.6	43.4	32.6	30.0	3.37	5.42	9.0	28.4	33.5	65.3
T6 (100% Vermicompost+Rhizobium)	14.3	35.8	40.3	32.3	29.3	3.10	5.36	8.6	29.7	34.6	65.8
T7 (100% NPK+50%VC+100%Rhizobium)	15.5	37.6	48.6	33.0	30.0	3.64	5.61	8.9	30.2	35.2	63.4
T8 (50%NPK+50%VC+100%Rhizobium)	15.1	35.7	42.2	32.6	29.6	3.38	5.40	8.6	29.9	34.9	62.4
S. Em ±	0.06	0.05	0.06	1.20	0.96	0.063	0.050	0.063	0.71	0.57	0.85
CD (0.05)	0.14	0.10	0.13	NS	NS	0.149	0.104	0.137	1.54	1.24	1.82

Table 2: Effect of different Integrated Nutrient Management treatments on yield Parameters:

Treatments	No. of Pods Plant-1	No. of Seeds Pod 1	Pod length (cms)	Root nodules plant-1 (mg)		Weight of 100 seeds (gms)	Grain yield plant-1 (gms)	Grain yield plot-1 (kg)
				45 DAS	60 DAS			
T1 (Control)	19.6	4.6	4.1	14.5	13.1	3.2	3.12	0.386
T2(100% NPK/ha)	25.8	5.3	4.5	13.1	11.2	3.6	4.82	0.689
T3(100%FYM+Rhizobium)	24.6	5.0	4.2	18.3	16.0	3.4	4.18	0.597
T4 (100%NPK+50%FYM+Rhizobium)	31.6	6.6	5.2	14.0	12.0	4.3	8.06	1.221
T5 (50% NPK+50%FYM+Rhizobium)	29.8	5.6	4.9	16.8	15.1	4.0	6.67	1.005
T6 (100% Vermicompost+Rhizobium)	26.0	5.0	4.6	17.6	15.5	3.8	5.23	0.766
T7(100%NPK+50%VC+100%Rhizobium)	30.6	6.3	5.1	13.5	11.1	4.1	7.90	1.205
T8(50%NPK+50%VC+100%Rhizobium)	28.6	5.3	4.8	16.6	14.0	3.9	6.02	0.891
S. Em ±	0.06	0.03	0.02	0.57	0.25	0.15	0.28	0.35
CD (0.05)	0.14	0.07	0.05	1.22	0.55	0.33	0.60	0.76

Table 3: Effect of different Integrated Nutrient Management treatments on final yields:

Treatments	Grain yield (kg ha-1)	Stover yield (kg ha-1)	Biological yield (kg ha-1)	Harvest Index (%)
T1(Control)	873	2625	3498	24.9
T2(100% NPK/ha)	1378	2759	4137	33.3
T3(100%FYM+Rhizobium)	1195	2701	3896	30.6
T4 (100%NPK+50%FYM+Rhizobium)	2442	3056	5498	44.5
T5(50% NPK+50%FYM+Rhizobium)	2001	2852	4853	41.2
T6(100% Vermicompost+Rhizobium)	1532	2791	4323	35.4
T7(100% NPK+50%VC+100%Rhizobium)	2370	2944	5314	44.4
T8(50%NPK+50%VC+100%Rhizobium)	1782	2823	4605	38.6
S. Em ±	0.23	3.41	5.31	0.31
CD (0.05)	0.49	10.36	16.10	0.93

Table 4: Effect of Integrated Nutrient Management on Economics of different Treatments:

Treatments	Economics		
	Gross Monetary Returns (Rs/ha)	Net Monetary Returns (Rs/ha)	B:C ratio
T1(Control)	46,275.00	24,075.00	1.1
T2(100% NPK/ha)	71,659.00	48,079.00	2.0
T3(100%FYM+Rhizobium)	62,451.00	36,251.00	1.3
T4(100%NPK+50%FYM+Rhizobium)	1,25,156.00	95,436.00	3.2
T5(50% NPK+50%FYM+Rhizobium)	1,02,902.00	73,872.00	2.5
T6(100% Vermicompost+Rhizobium)	79,391.00	49,051.00	1.6
T7(100% NPK+50%VC+100%Rhizobium)	1,21,444.00	91,724.00	3.0
T8(50%NPK+50%VC+100%Rhizobium)	91,923.00	64,893.00	2.3

Conclusion

This study revealed that the maximum plant height has been obtained at various growth stages (30, 60 DAS and at harvest stage) of the crop by 20:60:20 kg NPK ha-1 + FYM 2 ton ha-1 + Rhizobium (T4) and 20:60:20 kg NPK ha-1 + VC 1 t ha-1 + Rhizobium (T7) respectively. It was also found most effective in various yield and yield contributing traits of black gram Highest Net. Return and B: C Ratio was recorded at 20:60:25 kg NPK ha-1 + FYM 2 ton per ha + Rhizobium (T4). Overall, it was observed that the application of 20:60:20 kg NPK ha-1 + FYM 2 ton ha-1 + Rhizobium (T4) was found most effective for increasing the number of pods plants-1, number of seeds per plant, and seed yield q ha-1.

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